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13. ABSTRACT

This report documents the Fleet Readiness Training (FRT) Planning model developed as part of the third phase of the Integrated Facilities Requirements Study (IFRS).

In Phase I, two analytic submodels were developed. The first, a Logistics Support Requirements Generator, estimates personnel, aircraft, and fuel requirements for each phase of undergraduate pilot training at the Naval Air Training Command (NATRACOM). The second, a Pacing Facilities Requirements submodel, calculates facility requirements for each phase of training.

The purpose of the Phase II study was to develop a preliminary total systems IFRS management planning tool (including the two submodels developed in Phase I, as well as Base Loading, Facilities Excess/Deficiency, and Total Cost submodels), and automate the model so that it provides quick, accurate, and relevant information for use in the decision-making process. This Static IFRS model has been in continuous operation since March 1970.

The purpose of the Phase III study was to refine the Static IFRS model and to expand the IFRS concept by developing three additional planning tools for use by Navy decision-makers as follows: OVER

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- Optimization model and
- Fleet Readiness Training Squadron planning tool.

The Dynamic planning tool simulates the undergraduate pilot training program on a weekly basis whereas the Static IFRS assumes an even annual flow of students. The Optimization model has two segments - a PTR Maximizer that calculates the maximum annual pilot training rate (PTR) possible for a given facilities inventory and a MCON Minimizer that calculates the minimum facility cost phase-to-base assignment for a desired PTR. The Fleet Readiness Training (FRT) model provides planning information for the readiness training squadrons and is designed similarly to the Static IFRS model. The Phase III documentation consists of the following four reports:

- The Integrated Facilities Requirements Study (IFRS) Phase III, ORI TR 645
- Development of the Automated Dynamic Model for the Integrated Facilities Requirements Study (IFRS) Phase III, ORI TR 646
- Development of the Optimization Model for the Integrated Facilities Requirements Study (IFRS) Phase III, ORI TR 647
- Development of the Fleet Air Readiness Training Model for the Integrated Facilities Requirements Study (IFRS) Phase III, ORI TR 648.

This report documents the Fleet Readiness Training (FRT) Model. Volume I contains a Summary of the FRT model and the functional relationships. Appendix B contains the present squadron planning factors and is under separate cover in Volume II. Volume III contains the User's Manual stating how to use the planning tool. The Programmer's Manual is contained in Volume IV.

OPERATIONS RESEARCH, Inc.

SILVER SPRING, MARYLAND

Development of the Fleet Air Readiness Training Model for the Integrated Facilities Requirements Study (IFRS) Phase III

Volume I - Summary of the Fleet Readiness Training (FRT) Management Planning Tool

31 March 1971

Prepared under Contract N00025-67-C-0031 (NBy-78672)
for the Naval Facilities Engineering Command
Department of the Navy
Washington, D.C.

FOREWORD

This report documents the Fleet Readiness Training (FRT) planning model developed as part of the third phase of the Integrated Facilities Requirements Study (IFRS). It has been prepared for the Systems Analysis Division of the Office of the Assistant Commander for Facilities Planning (Code 20), Naval Facilities Engineering Command (NAVFAC), Department of the Navy, as part of Contract N00025-67-C-0031 (NBy-78672) awarded to Operations Research, Inc., in June 1970.

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These IFRS models were developed and programmed by the staff members of the Economic Analysis Division of Operations Research, Inc., under the direction of Dr. William J. Leininger, vice president and division director and Thomas N. Kyle, program director. The project team members included R. J. Craig, M. C. Fisk, W. Liggett, F. McCoy, R. Messalle, and R. Yockman.

Mr. Dennis Whang of the Systems Analysis Division of Facilities Planning was contract monitor for NAVFAC. In addition, valuable assistance was provided by many other Navy personnel including, in particular, those in the Office of the Staff Civil Engineer and the Training/Plans Division of the Naval Operations, and in the Systems Analysis Division of NAVFAC. The authors gratefully acknowledge the contributions made by all of these people to the development of the IFRS models.

SUMMARY

This report documents the Fleet Readiness Training (FRT) planning model developed as part of the third phase of the Integrated Facilities Requirements Study (IFRS). The objective of this task is to develop an automated management planning tool that quickly generates relevant Fleet Air Readiness Training Squadron planning information required by the Aviation Training Division of the Chief of Naval Operations.

The FRT model essentially replicates the Navy's present planning process by simulating the Fleet Air Readiness Training program on a time-share computer system. The model calculates the student, instructor, aircraft, and squadron requirements for alternative squadron configurations as a function of one of four variables—student input, student output, aircraft inventory, and aircraft operating costs.

The FRT model is programmed and is presently operational on a time-share computer system. The computer programs are written in a conversational mode which permit the decision-maker to easily enter his own input data and use the model without knowledge of the FORTRAN programming language. The use of the planning tool by Navy decision-makers will benefit the pilot training program by enhancing effective management in the following ways:

- Frees management from making voluminous routine calculations
- Provides the capability to test and analyze the consequences of alternative decisions
- Quickly generates timely, accurate, and relevant information
- Permits a large set of alternatives to be analyzed in great depth
- Provides a common basis for computing resource requirements and comparing alternatives.

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I. INTRODUCTION

OBJECTIVE

1.1 The objective of this study is to develop an automated management planning tool that quickly generates relevant Fleet Air Readiness Training Squadron planning information required by the Aviation Training Division of the Chief of Naval Operations (CNO). This new planning tool is one of the series of management tools developed under the Integrated Facilities Requirements Study (IFRS) and must:

- Be similar in concept and design to the Logistics Support Requirements (LSR) module developed for the undergraduate pilot training program of the Naval Air Training Command (NATRACOM).1/
- Be capable of estimating resource requirements as a function of annual student flow.
- Be flexible so that the manager can enter either student flow or available resources.
- Be capable of providing answers to the "what if" questions most frequently asked.
- Be programmed in a time-share conversational mode.
- Be available for use within 3 months.

1/ Integrated Facilities Requirements Study Phase II—Development of a Preliminary Automated Total Systems Model, ORI TR 583, 9 January 1970.

STUDY PRODUCT

1.2 The end product of this effort consists of an operational Fleet Readiness Training (FRT) planning tool and relevant documentation. The FRT model is programmed in a time-share mode and is presently providing useful planning information to the Aviation Training Division of CNO on a daily basis. In fact, the FRT model was operable within the 3-month period and has been providing answers to a multitude of "what if" questions since October 1970.

1.3 The documentation provided by ORI includes this summary volume, an appendix volume, containing the squadron planning factors and related computer data files, a user's manual, and a programmer's manual.

II. OVERVIEW OF THE FLEET READINESS TRAINING (FRT) MODEL

INTRODUCTION

2.1 The FRT planning tool essentially replicates the Navy's present planning process by simulating the Fleet Air Readiness Training program on a time-share computer system. Initially, the Fleet Air Readiness Training production process had to be identified with the inputs, required resources, student flow process, constraints, and outputs clearly defined. Next, this production process was simulated on a time-share computer system by developing the appropriate mathematical relationships, pertinent planning factors, and necessary computer programs. The resulting FRT tool provides the manager with substantial flexibility and benefits to ensure its viability in the management decision process. It should be noted that an overriding assumption inherent in the present planning process and also incorporated into this FRT model is that there is assumed to be an even annual flow of students in a squadron.

FLEET AIR READINESS TRAINING PRODUCTION PROCESS

2.2 The Navy's Aviation Readiness Training program provides the specialized training required for pilots and naval flying officers (NFOs) to become qualified to fly in a particular type of fleet aircraft. The squadron is the basic training unit and, in general, one or two squadrons conduct training for each type of fleet aircraft. Currently there are approximately 25 squadrons conducting training at naval air stations (NAS) throughout the United States. The number and type of squadrons change continuously as the inventory of fleet aircraft changes. CNO is responsible for the overall management and planning of these squadrons.

2.3 Even though each squadron operates essentially independently, the overall method of training, or the production process follows a basic pattern.

Figure 2.1 illustrates this basic production process for a typical squadron. The top block represents the inputs to the production process (i.e., the students entering this training program). The center block represents the resources either consumed or utilized during the actual training (production) process. Some of the external factors that affect this process are indicated by the arrows pointing toward the production block. Finally, the output from this system (i.e., trained pilots or NFOs) is illustrated by the third block.. This training process is discussed in more detail below.

Student Inputs

2.4 All Navy pilots and NFOs are sent to a readiness training squadron prior to fleet assignment. The total number of pilots and NFOs required to operate the fleet aircraft is determined by CNO. The steady influx of new pilots, the rotational policies (i.e., tour of duty split between sea and shore assignments), the steady outflow of men from the Navy, the changes in aircraft inventory, etc., result in the need for training men who have a variety of backgrounds or skill levels. All students (i.e., pilots and NFOs) entering a readiness training squadron have at least one thing in common—they have received their wings from the Naval Air Training Command (NATRACOM). However, the experience and skill levels of these students vary depending upon their previous assignments. In order to segregate students with similar skill levels into discrete units, the students entering the squadron are identified by "category" levels. For example, a recent pilot graduate of NATRACOM who has never flown in the fleet is generally a category 1 student. A pilot recycling from a desk assignment may be either a category 2 or 3, depending on his previous flight experience. The NFOs are also identified by category levels in a similar manner.

Training Categories

2.5 Each pilot and NFO category is defined by the syllabus which specifies the flight and academic requirements that the student must successfully complete prior to completing his readiness training. There is no limit to the number of categories a squadron can have; however, each usually has between 6 and 10. In general, category 1 students must complete 100% of the syllabus, category 2 completes 80%, and category 3 completes 50%, etc., with each category being completed in proportionate time periods.

2.6 The NFO syllabus requirements are also graduated in a similar way. Figure 2.2 illustrates the pilot and NFO flow through a hypothetical squadron with six categories. The students from all sources are assigned to one of the categories as a function of their skill level. They complete the syllabus requirements and are then assigned to a fleet aircraft squadron. It should be noted that this chart is for illustrative purposes and the actual squadrons are not necessarily made up of these distinct categories.

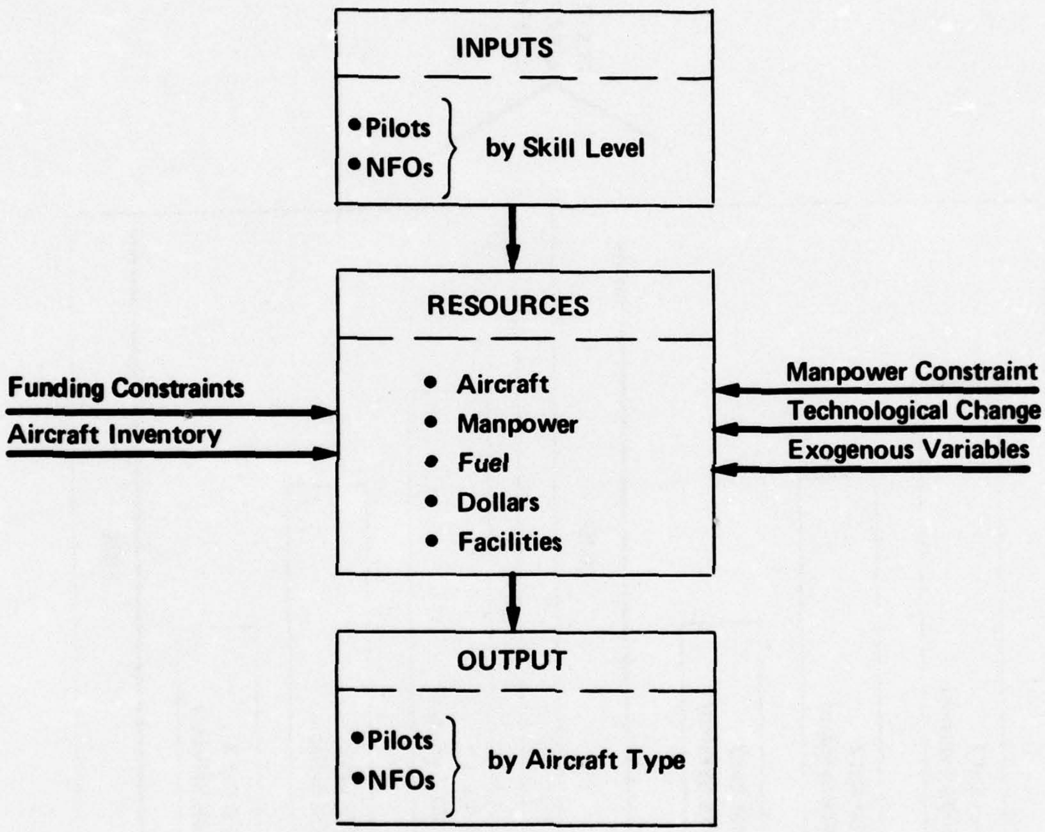

FIGURE 2.1. FLEET READINESS TRAINING PRODUCTION PROCESS

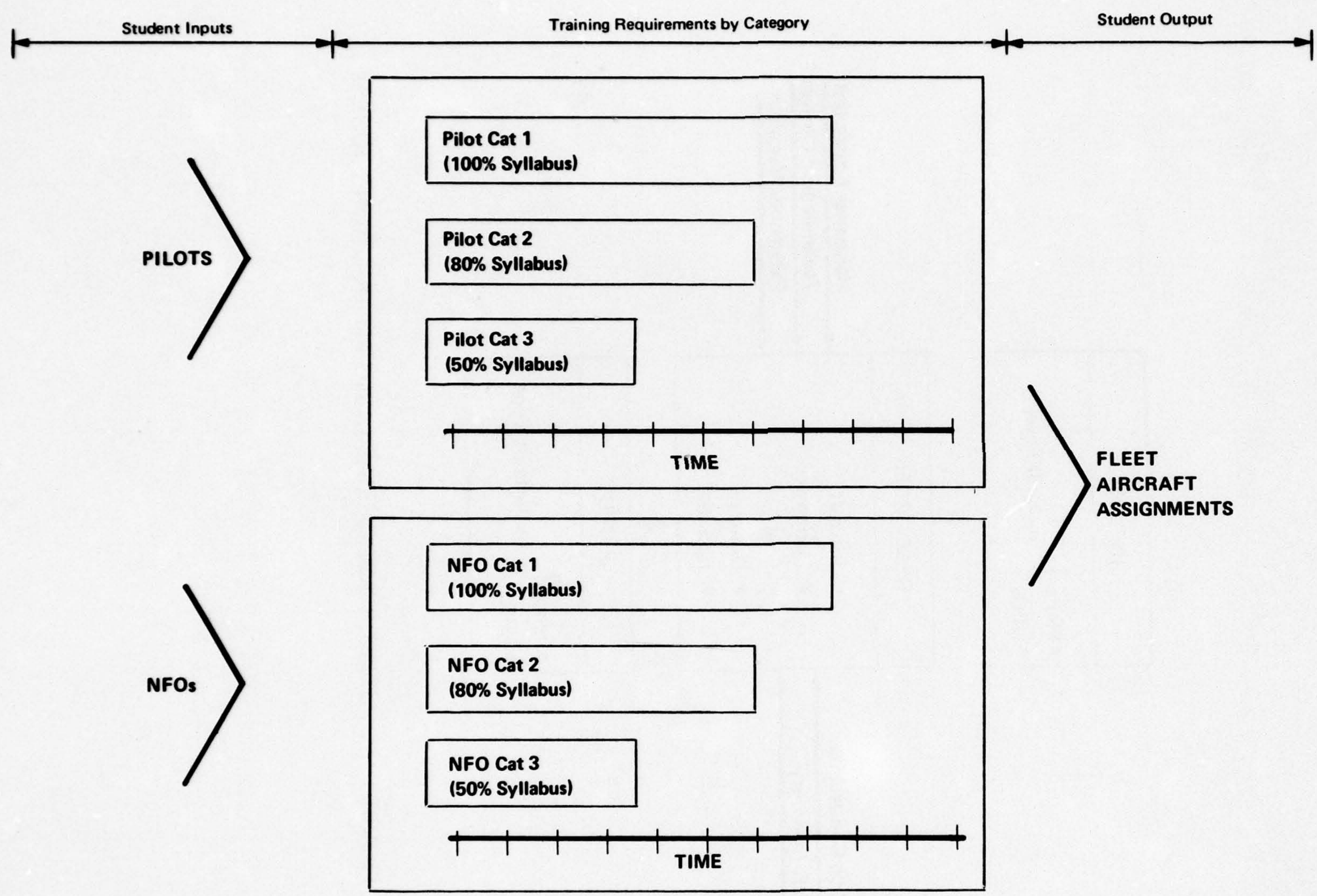

FIGURE 2.2. SAMPLE SQUADRON TRAINING

Resource Requirements

2.7 The primary resources either consumed or utilized during this training process are aircraft, manpower, fuel, dollars, and facilities. The manpower resources are divided into instructors, enlisted men, and other squadron personnel. Since up to three different types of instructors (i.e., pilot, NFO, and crewman/navigator) may be required for each category, instructor requirements for student pilots and NFOs must be clearly delineated. Any student (i.e., pilot or NFO) may require instruction from an instructor pilot (IP), instructor NFO (INFO), or an instructor crewman/navigator (ICN). The number of different instructors required by each student is determined by the syllabus. However, it is recognized that a pilot must learn how to interface with an NFO during flight and the NFO must similarly interface with the pilot—thus the student NFO flys with the student pilot whenever possible. The syllabi specifically states those pilot and NFO flights that require instructors, and those that are flown with both a student pilot and student NFO.

2.8 Aircraft requirements are also defined by the syllabus and account for the unique flight requirements of each category as well as dual usage by student pilots and NFOs. The fuel requirements and dollar requirements are a function of the aircraft utilization. Facility requirements are then determined by the total NAS population and aircraft inventory.

Constraints

2.9 Like all production processes, the readiness training squadron has a limited supply of resources and each squadron must operate within these constraints. Some of the constraints within which a squadron must operate were shown in Figure 2.1. The aircraft inventory is often less than desirable, and, therefore, the available aircraft must be carefully scheduled to meet the demands. The number and type (i.e., pilot, NFO, and crewman/navigator) of available instructors may not be exactly what is required. The dollars available to maintain and operate the aircraft may be limited. Weather may and often does drastically affect the training operations. The introduction of a new fleet aircraft may result in the formation of a new squadron. The main point is that the readiness training squadrons operate in a dynamic environment and also within certain constraints and limitations.

Students Leaving

2.10 Once a student has completed the flight and academic requirements of the squadron, he graduates as either a pilot or NFO. This man is ready for an assignment to a squadron with the same type of aircraft that he flew in the readiness training squadron.

AUTOMATED FRT MANAGEMENT PLANNING TOOL

2.11 The automated FRT planning tool consists of several mathematical relationships, a multitude of planning factors, and a series of computer programs which when combined essentially replicate the fleet readiness training production process described previously. The FRT model presently consists of one module—the Logistics Support Requirements (LSR) module1/. The purpose of the LSR module is to calculate manpower, aircraft, fuel, and aircraft operating cost required to conduct pilot and NFO training training at a readiness training squadron independent of a specific geographic location.

2.12 The following discussion highlights the inputs required to operate the FRT model, the methodology employed, and the information (i.e., model output) provided to the decision-maker. Throughout this discussion a hypothetical squadron, TESTSQD2, is used to illustrate how the decision-maker can use the FRT model to obtain relevant planning information.

Inputs

2.13 Two types of inputs are required to operate the FRT planning tool:

- Planning factors
- Throughput specification.

2.14 Planning factors. The planning factors consist of two groups—the category planning factors that define each category of training and the squadron support factors that define the fixed squadron personnel required (e.g., headquarters personnel) in addition to those associated with the categories.

2.15 The following planning factors are required to define each category of training within the squadron and are entered first:

a. Name of category

b. Number and type(s) of aircraft used in the phase (maximum of three aircraft types per category)

c. Type of fuel and consumption rate for the above aircraft

d. Flyable weather (percent of time a scheduled mission is flown)

e. The number of maintenance men required per aircraft

f. Operating cost per flight hour for the above aircraft

1/ The IFRS contract limited the scope of the FRT model to the LSR module.

g. Aircraft utilization assuming perfect weather

h. Aircraft flight hours required per student output (including overhead hours)

i. Length of training in weeks

j. Student attrition rate

k. Point at which students attrite

l. Tour of duty for flight instructors (IP), NFO instructors, (INFO), and crewman/navigator instructors (ICN)

m. Instructor training period for IP, INFO, and ICN

n. Instructor utilization assuming perfect weather for IP, INFO, and ICN

o. Instructor flight hours required per student output including overhead hours for IP, INFO, and ICN

p. Number of students supported by one other instructor, i.e., academic instructor (ACD), landing signal officer (LSO), and weapons system training (WST) officer.

2.16 After the planning factors have been entered for each category, the following squadron personnel support factors are entered:

a. Number of squadron administrative IPs and INFOs

b. Number of nonaviator officers required for administrative, maintenance, and other functions

c. Number of enlisted support personnel required for training, detachment, site, administration, and crew support functions.

The number of squadron support personnel depends on factors exogenous to the readiness training system and thus are entered as fixed quantities rather than estimated by the model.

2.17 These planning factors represent the basic data file of the FRT planning tool and are stored in the computer. Consequently, it is not necessary to re-enter these data each time the manager uses the model. Both temporary and permanent changes to these data files can be completed by following the simple instructions in the user's manual. A listing of these category and squadron factors currently stored in the computer for a hypothetical test squadron, TESTSQD2,

appears in Table 2.1. Note that the three pilot categories have two types of aircraft as well as two types of instructors required. If the manager desires, he can have these planning factors printed by the time-share terminal as shown for FRP[2] Cat 1 in Table 2.2.

2.18 Throughput Specification. Once the basic data files have been established, the manager can start to ask the "what if" questions to the FRT model. Initially, he must enter the annual number of weeks and annual number of days scheduled to be flown. The current planning factors are 50 and 271 respectively as shown at the top of Table 2.3. He then selects the squadron for his analysis by simply typing in its name, as shown by the underlined name in the center of Table 2.3, and the categories presently in that squadron are printed by the terminal as shown. In this example there are three pilot categories and two NFO categories. He then chooses one of the four data input options that define the throughput for each category. Depending on his analytic need, he can choose to enter student input, student output, available aircraft, or available aircraft operating costs. As shown in the example, in Table 2.3, he desired to enter student input or option 1.

2.19 For this example, assume the manager wants to train 100 pilots and 50 NFOs. The distribution of this throughput by category and the way in which he enters this throughput into the terminal appears in Table 2.4. Since the user previously chose to enter student input, the computer asks the question as shown. He simply types the category number and the student input for each category (e.g., 1,50 means a student input of 50 for category 1, etc.). After these data are entered, the FRT model begins to calculate the useful planning information.

General Methodology

2.20 The methodology employed in the FRT planning tool essentially replicates that presently in use by the Navy. It consists of a series of equations and data files related in a manner which provides management with the necessary planning information.

2.21 This methodology can be divided into the four discrete areas:

- Student information
- Aircraft information
- Instructor information
- Squadron summary information.

The information calculated by the model is further delineated in Figure 2.3 and discussed in the following paragraphs.

2/ Fleet readiness pilot.

TABLE 2.1

PLANNING FACTORS REQUIRED FOR SAMPLE SQUADRON
(TESTSQD2)

Planning Factors	FRP CAT 1		FRP CAT 2		FRP CAT 3		NFO CAT 1	NFO CAT 2			
AC type	F-4	TA-4	F-4	TA-4	F-4	TA-4	F-4	F-4			
Fuel type	JP-4	JP-4	JP-4	JP-4	JP-4	JP-4	JP-4	JP-4			
Fuel consumpt rate	100.0	75.0	100.0	75.0	100.0	75.0	100.0	100.0			
% flyable weather	0.95	0.90	0.95	0.90	0.95	0.90	0.95	0.95			
Maint men, MO factor	20.0	10.0	20.0	10.0	20.0	10.0	20.0	20.0			
AC $/flight hr	325.0	100.0	325.0	100.0	325.0	100.0	325.0	325.0			
AC util, hr/day	2.29	2.01	2.29	2.01	2.29	2.01	1.58	1.58			
AC hr/student out	152.2	4.5	120.0	2.6	79.3	1.2	69.5	52.5			
CAT duration, wk	25.0		21.0		12.0		24.0	20.0			
Attrition rate	0.02		0		0		0.06	0			
Attrition point	0.9		0.9		0.9		0.9	0.9			
Tour of duty, mo											
IP	24.0	—	24.0	—	24.0	—	24.0	24.0			
INFO	24.0	—	24.0	—	24.0	—	—	—			
ICN											
Time to train instr, mo											
IP	2.0	—	2.0	—	2.0	—	2.0	2.0			
INFO	2.0	—	2.0	—	2.0	—	—	—			
ICN											
Instr util, hr/fly day											
IP	2.22*	—	2.22*	—	2.22*	—	2.22	2.22			
INFO	2.22*	—	2.22*	—	2.22*	—	—	—			
ICN											
Instr hr/student out											
IP	44.0	—	34.6*	—	19.4*	—	69.5	52.5			
INFO	66.6*	—	46.5*	—	26.0*	—	—	—			
ICN											
LSO/WST ratio											
IP	4.1	—	4.1	—	4.1	—	—	—			
INFO	—	—	—	—	—	—	3.3	3.3			
ICN											

	IP	INFO	Ground	Maint Ground	Other
Administrative	4	1	3	11	1
	Trg	Det	Site	Admin	Crews
Enlisted Support	**49**	**19**	**24**	**94**	**0**

* Includes both F-4 and TA-4 instructor requirements.

TABLE 2.2

COMPUTER PRINTOUT OF PLANNING FACTORS FOR ONE CATEGORY OF SAMPLE SQUADRON

```
 1 CATEGORY NAME - - - - - - - -FRP CAT 1
 2 NUM. OF TYPES OF AIRCRAFT      2
 3 WEEKS TO COMPLETE TRAINING   25.0
 4 ATTRITION RATE(100%=1.)        0.020
 5 ATTRITION POINT                0.900
 6 TOUR OF DUTY FOR - - - - -   IP      INFO    IC/N
     (MONTHS)                   24.      24.      0.
 7 TRAINING PERIOD FOR- - - -   IP      INFO    IC/N
     (MONTHS)                    2.       2.      0.

 8 AIRCRAFT TYPE              F-4       TA-4
 9 MO FACTOR                  20.00     10.00
10 WEATHER(100%=1.)            0.950     0.900
11 FUEL TYPE                  JP-4      JP-4
12 FUEL CONSUMPTION           100.00    75.00
13 $ PER FLIGHT HOUR          325.00   100.00
14 A/C FLT. HRS/DAY             2.29      2.01
15 A/C HOURS/STUDENT          152.20      4.50
16 INSTRUCTION TYPES
  (1=IP,2=INFO,3=IC/N)        1,2,0     0,0,0
17 IP   UTILIZ.(FLY.DAY)       2.22     0.
18 INFO UTILIZ.(FLY.DAY)       2.22     0.
19 IC/N UTILIZ.(FLY.DAY)       0.       0.
20 IP   INSTR HRS/STUD.       44.00     0.
21 INFO INSTR HRS/STUD.       66.60     0.
22 IC/N INSTR HRS/STUD.        0.       0.
23 IP   ACD/LSO/WST RATIO      4.10     0.
24 INFO ACD/LSO/WST RATIO      0.       0.
25 IC/N ACD/LSO/WST RATIO      0.       0.
```

TABLE 2.3

MODEL INPUT DATA REQUIRED

```
Q-2.  ENTER TRAINING WEEKS PER YEAR
  AND ANNUAL FLY-DAYS (XX.,XXX.)?50,271

Q-4.  ENTER SQUADRØN NAME (AAAAAAAA)?TESTSQD2

READINESS SQUADRØN: TESTSQD2 HAS  5 CATEGØRIES


    READINESS SQUADRØN: TESTSQD2
CAT. NØ.     CAT. NAME
    1        FRP CAT 1
    2        FRP CAT 2
    3        FRP CAT 3
    4        FRNFØ CAT 1
    5        FRNFØ CAT 2

Q-6.  ENTER DATA INPUT ØPTIØN
  1  STUDENT INPUT TØ CAT
  2  STUDENT ØUTPUT
  3  THØUS $ FØR FLYING
  4  NUMBER ØF AIRCRAFT  ?1
```

TABLE 2.4

STUDENT INPUT DATA

Student Input Distribution

Pilots		NFO	
Category	Value	Category	Value
1	50	4	30
2	35	5	20
3	15		

Student Input Entered into Model

```
Q-7.  ENTER CAT. NO. AND STUDENT INPUT TO CAT (XX,XXX)?1,50
NEXT?2,35
NEXT?3,15
NEXT?4,30
NEXT?5,20
NEXT?0,0
```

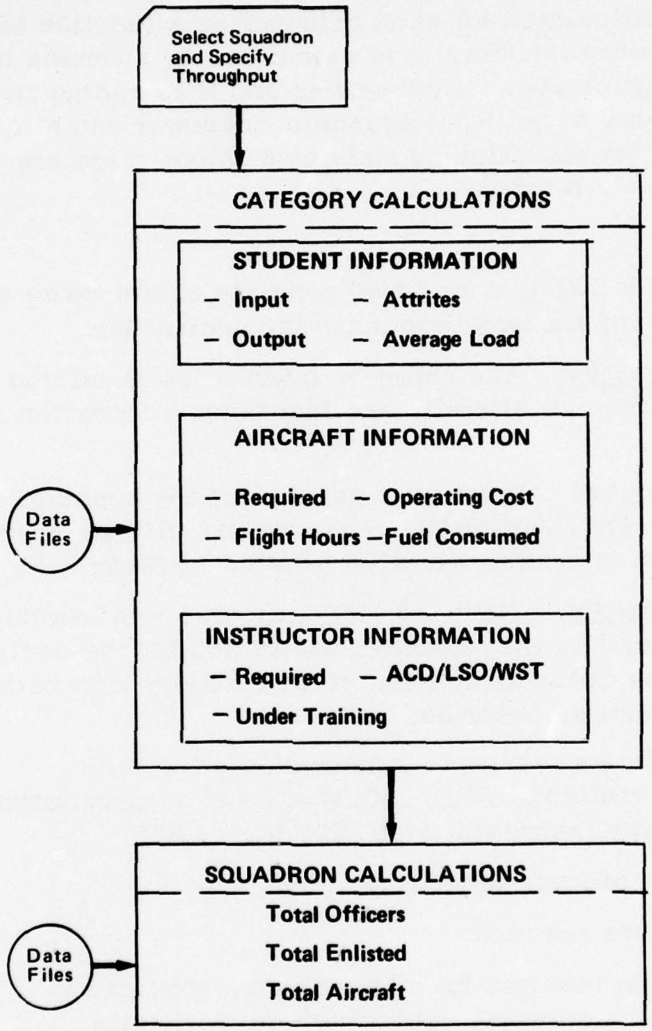

FIGURE 2.3. OVERVIEW OF FRT METHODOLOGY

2.22 Initially, the model calculates the category student throughput as defined by the value of the throughput specification variables (i.e., student input, student output, available aircraft, available aircraft operating cost) entered by the manager. Next the student attrites and student load (i.e., average students on board throughout the year) are calculated. The aircraft and instructor information is then calculated for each category as a function of this throughput. The squadron summary information is calculated by summing instructor and aircraft category information over all categories and then adding the unique squadron personnel requirements to get total squadron manpower and aircraft requirements. The details of this methodology and assumptions made are discussed in detail in Appendix A of this report.

FRT Model Output

2.23 The output of the FRT planning tool consists of two major parts—a set of category information and the squadron summary information.

2.24 Category Information. The category information is printed for each category and includes student, aircraft, and instructor information as shown in Table 2.5.

2.25 A sample printout of category information for the hypothetical squadron, TESTSQD2, with the student input of 100 pilots and 50 NFOs, appears in Table 2.6. Note that the information is printed exactly as listed in Table 2.5.

2.26 Squadron Information. Next the total officers, total aircraft, and total enlisted personnel required by the squadron are printed for the decision-maker. This information consists of the summation of all category information plus the squadron support personnel as described below.

a. Aviator officers required by instructors, instructors under training, ACD/LSO/WST, and administrative for each type instructor (i.e., IP, INFO, ICN)

b. Nonaviator officers required

c. Total officers required

d. Enlisted men required for maintenance, administration, training support, detachment support, site support, and crews

e. Total enlisted men required

f. Total aircraft required by type

g. Total aircraft hours required by type

h. Total aircraft operating cost by type of aircraft

i. Total fuel consumed by type of aircraft

j. Total maintenance men by aircraft type.

A sample computer printout of the squadron summary information appears in Table 2.7.

TABLE 2.5

CATEGORY OUTPUT INFORMATION

<u>Student Information</u> • Annual student input—the number of students entering each category • Annual student output—the number of students successfully completing the training requirements • Student attrites—the number of students who fail to complete training requirements • Student load—average number of students in each category throughout the year <u>Aircraft Information</u> • Number required by type with maximum of three different types allowed for each category • Annual hours flown by each aircraft type • Annual operating cost by aircraft type • Annual fuel consumption by aircraft and fuel type • The MO factor or number of maintenance men required per aircraft by aircraft type <u>Instructor Information</u> • Number of instructors by type (i.e., pilot, NFO, or crewman/navigator) • Number of instructors by type under training (i.e., men required to replace present instructors who are to be rotated) • Number of other instructors (ACD/LSO/WST) required by aircraft type

TABLE 2.6

CATEGORY INFORMATION

READINESS SQUADRON: TESTSQD2

STUDENT STATISTICS

CAT. NAME	INPUT	OUTPUT	ATTRITES	LOAD
FRP CAT 1	50.00	49.00	1.00	24.95
FRP CAT 2	35.00	35.00	0.	14.70
FRP CAT 3	15.00	15.00	0.	3.60
FRNFO CAT 1	30.00	28.20	1.80	14.31
FRNFO CAT 2	20.00	20.00	0.	8.00
**TOTAL			2.80	65.56

AIRCRAFT STATISTICS

CAT. NAME	TYPE	NUM.	FLT.HRS.	COST	GALLONS	FUEL	MO
			- - - - -	(X1000)-	- - - -		
FRP CAT 1	F-4	12.65	7.46	2423.79	745.78	JP-4	20.00
	TA-4	0.45	0.22	22.05	16.54	JP-4	10.00
FRP CAT 2	F-4	7.12	4.20	1365.00	420.00	JP-4	20.00
	TA-4	0.19	0.09	9.10	6.82	JP-4	10.00
FRP CAT 3	F-4	2.02	1.19	386.59	118.95	JP-4	20.00
	TA-4	0.04	0.02	1.80	1.35	JP-4	10.00
FRNFO CAT 1	F-4	4.82	1.96	636.97	195.99	JP-4	20.00
FRNFO CAT 2	F-4	2.58	1.05	341.25	105.00	JP-4	20.00

INSTRUCTOR STATISTICS

CAT. NAME	A/C	* INSTRUCTORS		** UNDER TRAINING		** ACD/LSO/WST		*
	TYPE	IP	INFO	IC/N	IP	INFO	IC/N	IP	INFO	IC/N
FRP CAT 1	F-4	3.77	5.71	0.	0.31	0.48	0.	6.09	0.	0.
	TA-4	0.	0.	0.	0.	0.	0.	0.	0.	0.
FRP CAT 2	F-4	2.12	2.85	0.	0.18	0.24	0.	3.59	0.	0.
	TA-4	0.	0.	0.	0.	0.	0.	0.	0.	0.
FRP CAT 3	F-4	0.51	0.68	0.	0.04	0.06	0.	0.88	0.	0.
	TA-4	0.	0.	0.	0.	0.	0.	0.	0.	0.
FRNFO CAT 1	F-4	2.93	0.	0.	0.24	0.	0.	0.	4.34	0.
FRNFO CAT 2	F-4	1.57	0.	0.	0.13	0.	0.	0.	2.42	0.

TABLE 2.7

SQUADRON SUMMARY INFORMATION

SQUADRON SUMMARY

OFFICERS			
AVIATORS	IP	INFO	IC/N
INST.	10.90	9.24	0.
IUT	0.91	0.77	0.
ACD/LSO/WST	10.55	6.76	0.
ADMIN.	4.00	1.00	
	------	------	------
**SUBTOTAL	26.35	17.77	0.
NON-AVIATORS			
GRD.ADMIN.	3.00		
MAINT.GRD.	11.00		
OTHER	1.00		
**TOTAL OFFICERS:		59.13	

AIRCRAFT		
TYPE	F-4	TA-4
NUM.	29.19	0.67
HRS.(1000)	15.86	0.33
COST(1000)	5153.59	32.95
FUEL	JP-4	JP-4
GALS(1000)	1585.72	24.71
MAIN.ENL.	583.82	6.72

ENLISTED	
MAINT.	590.54
ADMIN.	59.05
TRNG.SUPP.	49.00
DET. SUPP.	19.00
SITE SUPP.	24.00
ADMN.SUPP.	94.00
CREWS	0.
***TOTAL	835.59

2.27 Note that the squadron resources are summed into those segments relevant to the decision-maker. For instance, he needs to know the distribution of officers between aviators and nonaviators. In this example, the manager knows that the squadron needs 26 IPs, 11 INFOs, and 15 nonaviators for a total of 52 officers.

2.28 The manager is also provided with a summary of aircraft requirements by type. Since the precise requirement is for 29.19 F-4 aircraft and .71 TA-4 aircraft, the manager requires a minimum of 1 TA-4 aircraft and either 29 or 30 F-4s, depending on his decision. The other factors, including cost, fuel consumption, and maintenance men, that are related to each aircraft type are also shown. Finally the total squadron enlisted strength is displayed with the calculated maintenance men and the fixed squadron factors for a total of 836 enlisted men.

FLEXIBILITY OF THE FRT PLANNING TOOL

2.29 The automation of the FRT model was completed with a strong emphasis on providing the Aviation Training Division of CNO with an easy-to-use, flexible planning tool that would calculate answers to a multitude of management questions concerning today's, as well as future, readiness training squadrons. To ensure this viability, the model was designed to calculate throughput for limited resources. It also contains three operating level options and the data files are easily modified.

Resource Constraint Mode of Operation

2.30 An extremely useful feature of the FRT model is the built-in capability to enter either the number of available aircraft or the aircraft operating cost budget to determine the maximum achievable throughput for the constrained resource. To illustrate the utility of this feature, assume that for the previous example, there were only 22 F-4 aircraft available for TESTSQD2 rather than the 29.19 required for the 150 student input. The manager chooses to distribute the aircraft among the 5 categories as shown in Table 2.8 and sees that he can accommodate 80 pilots and 33 NFOs (versus the 100 and 50 desired), assuming the syllabi, etc., remain constant.

2.31 The new student, aircraft, instructor category information and the squadron summary information based on the availability of 22 F-4 aircraft appear in Tables 2.9 and 2.10. A direct comparison of pertinent, unconstrained and constrained outputs appears in Table 2.11. Assuming the syllabus is fixed, he can now accommodate 113 (versus 150) students; however, the instructor, officer, aircraft, and enlisted men required are also lower as shown.

2.32 Several options are available to the manager at this point. First, he can increase the aircraft utilization and see how this influences student input. Second, he can decrease the aircraft flight hours required per student output. He can also change any or all planning factors and receive answers for each of these alternatives within a matter of minutes.

TABLE 2.8

AIRCRAFT INPUT DATA

Aircraft Distribution to Categories

Category	Value
1	9
2	6
3	2
4	4
5	1

How Entered to FRT

```
READINESS SQUADRØN: TESTSQD2 HAS  5 CATEGØRIES

Q-6.  ENTER DATA INPUT ØPTIØN
  1  STUDENT INPUT TØ CAT  .
  2  STUDENT ØUTPUT
  3  THØUS $ FØR FLYING
  4  NUMBER ØF AIRCRAFT  ?4
```

TABLE 2.9

CATEGORY INFORMATION BASED ON LIMITED NUMBER OF AIRCRAFT

READINESS SQUADRON: TESTSQD2

STUDENT STATISTICS

CAT. NAME	INPUT	OUTPUT	ATTRITES	LOAD
FRP CAT 1	35.57	34.86	0.71	17.75
FRP CAT 2	29.48	29.48	0.	12.38
FRP CAT 3	14.87	14.87	0.	3.57
FRNFO CAT 1	24.91	23.41	1.49	11.88
FRNFO CAT 2	7.75	7.75	0.	3.10
**TOTAL			2.21	48.68

AIRCRAFT STATISTICS

CAT. NAME	TYPE	NUM.	FLT.HRS.	COST	GALLONS	FUEL	MO
			- - - - -	(X1000)	- - - - -		
FRP CAT 1	F-4	9.00	5.31	1724.46	530.60	JP-4	20.00
	TA-4	0.32	0.16	15.69	11.77	JP-4	10.00
FRP CAT 2	F-4	6.00	3.54	1149.64	353.74	JP-4	20.00
	TA-4	0.16	0.08	7.66	5.75	JP-4	10.00
FRP CAT 3	F-4	2.00	1.18	383.21	117.91	JP-4	20.00
	TA-4	0.04	0.02	1.78	1.34	JP-4	10.00
FRNFO CAT 1	F-4	4.00	1.63	528.80	162.71	JP-4	20.00
FRNFO CAT 2	F-4	1.00	0.41	132.20	40.68	JP-4	20.00

INSTRUCTOR STATISTICS

CAT. NAME	A/C *	INSTRUCTORS		** UNDER TRAINING **			ACD/LSO/WST		*
	TYPE	IP	INFO	IC/N	IP	INFO	IC/N	IP	INFO	IC/N
FRP CAT 1	F-4	2.68	4.06	0.	0.22	0.34	0.	4.33	0.	0.
	TA-4	0.	0.	0.	0.	0.	0.	0.	0.	0.
FRP CAT 2	F-4	1.78	2.40	0.	0.15	0.20	0.	3.02	0.	0.
	TA-4	0.	0.	0.	0.	0.	0.	0.	0.	0.
FRP CAT 3	F-4	0.50	0.68	0.	0.04	0.06	0.	0.87	0.	0.
	TA-4	0.	0.	0.	0.	0.	0.	0.	0.	0.
FRNFO CAT 1	F-4	2.43	0.	0.	0.20	0.	0.	0.	3.60	0.
FRNFO CAT 2	F-4	0.61	0.	0.	0.05	0.	0.	0.	0.94	0.

TABLE 2.10

SQUADRON SUMMARY INFORMATION BASED ON LIMITED NUMBER OF AIRCRAFT

SQUADRON SUMMARY

OFFICERS			
AVIATORS	IP	INFO	IC/N
INST.	8.01	7.14	0.
IUT	0.67	0.59	0.
ACD/LSO/WST	8.22	4.54	0.
ADMIN.	4.00	1.00	
	------	------	------
**SUBTOTAL	20.90	13.27	0.
NON-AVIATORS			
GRD.ADMIN.	3.00		
MAINT.GRD.	11.00		
OTHER	1.00		
**TOTAL OFFICERS:		49.17	

AIRCRAFT		
TYPE	F-4	TA-4
NUM.	22.00	0.51
HRS.(1000)	12.06	0.25
COST(1000)	3918.32	25.14
FUEL	JP-4	JP-4
GALS(1000)	1205.64	18.85
MAIN.ENL.	440.00	5.13

ENLISTED	
MAINT.	445.13
ADMIN.	44.51
TRNG.SUPP.	49.00
DET. SUPP.	19.00
SITE SUPP.	24.00
ADMN.SUPP.	94.00
CREWS	0.
***TOTAL	675.64

TABLE 2.11

COMPARISON OF CONSTRAINED AND UNCONSTRAINED INFORMATION*

Type of Output	Unconstrained	Constrained
Student Input		
Category 1	50	36
Category 2	35	29
Category 3	15	15
Category 4	30	25
Category 5	20	8
	150	113
Instructors		
IP	11 (10.90)	8 (8.01)
INFO	9 (9.24)	7 (7.14)
Total Officers	52	45
Aircraft		
F-4	29 (29.19)	22
TA-4	1 (.67)	1 (.51)
Enlisted Men	836	676

* Parentheses indicate actual printout numbers.

Operating Options of the FRT Model

2.33 The decision-maker has a choice of three routes to enter the FRT planning tool depending on his analytic needs.

2.34 Level 1—Limited Set of Questions. The purpose of level 1 is to provide the user with a means of entering the FRT planning tool and quickly receiving his answers. In level 1, the standard data files are used in the calculations. The user simply identifies the squadron and then enters the throughput values.

2.35 Level 2—Detailed Set of Questions. The purpose of level 2 is to provide the user with a larger set of questions which may need to be incorporated into an analysis. For instance, he can select to print a list of all squadrons and the names of categories in a particular squadron. Again, the standard data files are used for the calculations.

2.36 Level 3—List and Modify Planning Factors. The purpose of this level is to provide the user with the capability to temporarily change selected planning factors for a particular analysis. Once he has changed the desired planning factors, he then automatically enters level 2.

Permanent Changes to Data Files

2.37 The basic data files are readily accessible and easy to change. In fact, data changes affect a very small segment of the program; thus, no new computer programming is required when, for example, a new squadron is added, an old squadron deleted, or planning factors for a squadron are changed. New squadrons can be added by typing in those data required to define each category and squadron factor. The total amount of data is a function of the number of categories included in the squadron.

III. CONCLUSION

3.1 The FRT model is programmed and operational on a time-share computer system. The output of the FRT model provides planning information identical to what previously was performed manually. The model calculates answers in a matter of minutes at the time-share terminal. Thus the decision-maker has plenty of time to analyze the answers and incorporate them into his decision-making process. The manager can quickly see how changes in his throughput affect the resource requirements. Similarly, he can determine what throughput he can support for a given aircraft inventory or aircraft operating cost budget.

3.2 The decision-maker must understand exactly what the model can and cannot do. The FRT model does not make decisions for management, but it does greatly facilitate the decision-making process by providing the necessary supporting information.

BENEFITS OF FRT

3.3 In particular, the use of the FRT planning tool by the Aviation Training Division of CNO will benefit the pilot training program by contributing to better management in the following ways:

- Frees management from making voluminous routine calculations
- Provides the capability to test and analyze the consequences of alternative decisions
- Quickly generates timely, accurate, and relevant planning information
- Permits management to evaluate a large set of alternatives in great depth
- Provides a common basis for computing resource requirements and comparing alternatives.

APPENDIX A

FRT PLANNING TOOL FUNCTIONAL RELATIONSHIPS

A.1 The purpose of this appendix is to delineate the functional relationships employed and the assumptions made in the FRT management planning tool. These functional forms are divided into the four areas of student, aircraft, instructor, and squadron equations. The model calculates the planning information for one squadron at a time and the following equations are identified by category within a squadron. The term "student" refers to either a pilot or NFO student.

A.2 Two basic assumptions were required for the development of this model:

- The student throughput is assumed to be an even annual level flow, i.e., students enter and leave the pilot training program at a continuous rate.
- The training program is independent of other activities located at that base.

These same assumptions were necessary for the development of the Naval Air Training Command planning tool (i.e., Static IFRS Model).[1]

A.3 The data required for each category and squadron are contained in the data files of the computer.

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[1] Integrated Facilities Requirements Study, Phase I—Development of the Two-Model System, ORI TR 520, 5 December 1968.

STUDENT FUNCTIONAL RELATIONSHIPS

Student Input and Student Output

A.4 The throughput of the FRT model can be defined in terms of either student input or student output and either equation (A.1) or (A.2) is used to calculate the second item when the first is given.

$$SI_i = SO_i/(1-ATR_i) \tag{A.1}$$

or

$$SO_i = SI_i(1-ATR_i) \tag{A.2}$$

where

SI_i = annual number of students who enter the i^{th} category of training in a squadron

SO_i = annual number of students who successfully complete the i^{th} category of training in the squadron

ATR_i = fraction of students who will attrite during the i^{th} category of training in the squadron.

Student Attrites

A.5 The number of students entering a category may exceed the student output due to attrition and the number of attrites for category i, ATT_i, is:

$$ATT_i = SI_i - SO_i \tag{A.3}$$

Student Load

A.6 These equations are based on an even annual flow of students and the average number of students on board at any one time is calculated as follows:

$$SL_i = \frac{[(SI_i)(EATR_i) + (SO_i)(1-EATR_i)]WK_i}{WPY} \tag{A.4}$$

where

SL_i = student load for i^{th} category

$EATR_i$ = point at which students attrite or portion of the i^{th} category expected to be completed by the attrited student

WK_i = number of weeks required to complete the i^{th} training category

WPY = scheduled number of flying weeks per year.

AIRCRAFT FUNCTIONAL RELATIONSHIPS

Annual Flight Hours

A.7 The number of aircraft required by a category of training depends upon a variety of factors including student output, aircraft utilization, syllabus content, weather, scheduled flying days, etc. The total annual flight hours required to train the student output are calculated in equation (A.5).

$$AFLTH_i^t = (SO_i)\,(FH_i^t) \tag{A.5}$$

where

$AFLTH_i^t$ = annual flight hours required for all type t aircraft in category i ($t \leq 3$)

FH_i^t = average number of type t aircraft flight hours, both overhead and syllabus, required for a student to successfully complete the i^{th} category.

Number of Aircraft

A.8 The number of aircraft of type t required in the i^{th} category, AC_i^t, is calculated by dividing the total annual flight hours, $AFLTH_i^t$, by the hours flown by each type t aircraft.

$$AC_i^t = \frac{AFLTH_i^t}{(AU_i^t)\,(AFD)\,(WX_i^t)} \tag{A.6}$$

where

AU_i^t = average daily number of hours an aircraft of type t may be utilized for training students in the i^{th} category assuming perfect weather

AFD = annual number of days which are scheduled for flight training

WX_i^t = weather factor or percent of scheduled flights actually flown for aircraft type t in category i.

A.9 Throughput Specified by Number of Aircraft. If the number of available aircraft is entered as the throughput variable, equations (A.5) and (A.6) are then solved for student output as shown in equation (A.7).

$$SO_i^t = \frac{(AC_i^t)\,(AU_i^t)\,(AFD)\,(WX_i^t)}{(FH_i^t)} \tag{A.7}$$

where

t = the first aircraft type in category i.

The numerator of equation (A.7) is the total flight hours available from the inventory of the first aircraft type in category i, and the denominator is the number of flight hours of aircraft type t required per graduate (i.e., student output).

Annual Aircraft Operating Cost

A.10 The annual aircraft operating cost is calculated by multiplying the annual flight hours by an average cost per flight hour:

$$COST_i^t = (AFLTH_i^t)(CPH_i^t) \tag{A.8}$$

where

$COST_i^t$ = annual aircraft operating cost for aircraft type t in category i

CPH_i^t = cost per flight hour of aircraft type t in category i.

A.11 Throughput Specified by Annual Operating Cost. If the annual aircraft operating cost budget is entered to define the throughput, equations (A.5) and (A.8) are solved for student output.

$$SO_i^t = \frac{(COST_i^t)}{(CPH_i^t)\ (FH_i^t)} \tag{A.9}$$

where

t = the first aircraft type in category i.

The ratio COST/CPH is the total type t aircraft flight hours for category i. By dividing this by the flight hours per student, the maximum student output is obtained.

Annual Fuel Consumption

A.12 The annual fuel consumption is also calculated as a function of annual aircraft flight hours.

$$FC_i^t = (AFLTH_i^t)\ (GH_i^t) \tag{A.10}$$

where

FC_i^t = annual gallons of fuel consumed by aircraft t in category i.

GH_i^t = fuel consumption rate for aircraft type t in category i.

INSTRUCTOR FUNCTIONAL RELATIONSHIPS

Number of Instructors

A.13 The number of instructors required to train students in the i^{th} category for aircraft type t is computed from equation (A.11).

$$INST^t_{j,i} = \frac{(SO_i)(IFH^t_{j,i})}{(IFU^t_{j,i})(AFD)(WX^t_i)} \tag{A.11}$$

where

$INST^t_{j,i}$ = number of type j instructors (i.e., where j = pilot, NFO, or crewman/navigator) required for category i and aircraft type t

$IFH^t_{j,i}$ = number of type j instructor hours required per student output for category i and aircraft type t (includes both syllabus and overhead hours)

$IFU^t_{j,i}$ = instructor utilization or the number of daily hours a type j instructor can be expected to devote to training in category i and aircraft type t.

SO_i, AFD, and WX^t_i are as defined previously.

A.14 The numerator of equation (A.11) represents the total number of annual hours of type j instructor time required to train the students in aircraft t and category i while the denominator is the total annual hours an individual instructor of type j devotes to training a student in aircraft type t in category i.

Number of Instructors Under Training (IUT)

A.15 Flight instructors are generally assigned to a training squadron for a single tour of duty, and thus they are periodically rotated to other assignments. Consequently replacement instructors are required, and these replacements must also undergo training to ensure standardization of instruction. To compute the number of instructors under training, equation (A.12) is used.

$$IUT^t_{j,i} = \frac{(INST^t_{j,i})\ (IT^t_{j,i})}{(ITL^t_{j,i})} \tag{A.12}$$

where

$IUT^t_{j,i}$ = number of type j instructors under training for aircraft type t in category i

$IT^t_{j,i}$ = number of months during which a potential type j instructor must undergo instruction in the ith category

$ITL^t_{j,i}$ = average tour of duty for a type j instructor for aircraft type t and category i.

The ratio IT/ITL represents the proportion of the tour of duty that an instructor will spend preparing for student instruction. This ratio is multiplied by the total instructor requirement from equation (A.11), and the result is the number of instructors under training.

Other Instructors (ACD/LSO/WST)

A.16 Other instructors required for training both pilots and NFOs are estimated as a function of student load as shown in equation A.13.

$$OI^t_{j,i} = \frac{SL_i}{K^t_{j,i}} \qquad \text{(A.13)}$$

where

$OI^t_{j,i}$ = number of flight instructors of type j required for aircraft type t in category i

$K^t_{j,i}$ = average number of students a single type j instructor can support for aircraft type t in the i^{th} category.

SL_i is as defined previously.

A.17 Since these instructors require a minimum of preparatory instruction prior to the time they are permitted to aid students, the required number is not increased to reflect a training period.

SQUADRON SUMMARY FUNCTIONAL RELATIONSHIPS

A.18 The squadron summary calculations essentially sum across all categories to obtain total requirements by type.

Number of Officers

A.19 The total number of instructors of type j required for the squadron are calculated in equation (A.14).

$$TAV_j = \sum_{i=1}^{m} \sum_{t=1}^{n} INST_{j,i}^{t} + \sum_{i=1}^{m} \sum_{t=1}^{n} IUT_{j,i}^{t} + \sum_{i=1}^{m} \sum_{t=1}^{n} OI_{j,i}^{t} + ADMIN_j \quad (A.14)$$

where

TAV_j = the total instructors of type j (or total aviators of type j) required by the squadron

$ADMIN_j$ = number of fixed administrative instructors of type j required for the squadron

m = number of categories in the squadron

n = number of aircraft types in category.

The three terms represent pure instructors, IUT, and other instructors of type j, respectively.

A.20 The total squadron officers are calculated in equation (A.15).

$$TOFF = \sum_{j=1}^{3} TAV_j + \sum_{q=1}^{3} NAO_q \quad (A.15)$$

where

TOFF = total officer requirements

NAO_q = the 3 types of fixed number of nonaviator squadron officers required.

Number of Enlisted Personnel

A.21 The number of enlisted personnel required to maintain the aircraft is directly related to the number of aircraft as shown in equation (A.16).

$$EM = \sum_{i=1}^{m} \sum_{t=1}^{n} [(AC_i^t)(MO_i^t)](EM_s) \quad (A.16)$$

where

MO_i^t = number of direct enlisted men required to support aircraft type t in category i

EM_s = a constant that converts direct enlisted support to total enlisted support.[2/]

The m and n are as previously defined.

A.22 The total maintenance personnel required is then the sum of the above plus the fixed squadron support personnel.

Number of Squadron Aircraft

A.23 The number of aircraft required is calculated in equation (A.17).

$$TAC_i^t = \sum_{i=1}^{m} AC_i^t \qquad (A.17)$$

The remaining aircraft factors are calculated in a similar manner.

2/ Ibid.